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ZOOLOGY.—*The genus* Trimosina *and its relationships to other genera of the Foraminifera.*[1] JOSEPH A. CUSHMAN, Sharon, Massachusetts.

In 1907 Schubert, in a paper entitled *Beiträge zu einer natürlicheren Systematik der Foraminiferen,*[2] dealt with the relationships of *Chrysalidina* d'Orbigny and some supposedly related genera, some of which he proposed at that time. In my recent work, *Foraminifera, their classification and economic use,*[3] I followed in part the relationships proposed by Schubert. In the last year or more it has been possible to study abundant material of some of these rare genera and to gain a much more adequate knowledge of them. Schubert's work was based on published figures and descriptions rather than on an actual study of specimens. I have now been able to study all of these genera from suites of specimens, and some changes in the relationships as given by Schubert are inevitable.

The genus *Chrysalidina* d'Orbigny is monotypic, the Cretaceous species *C. gradata* d'Orbigny being the only one known, as *C. dimorpha* H. B. Brady was made the type of a new genus *Chrysalidinella* by Schubert. At the École des Mines in Paris, I was enabled through the kindness of Dr. H. Douvillé to examine a series of *Chrysalidina gradata* d'Orbigny. The wall of these specimens is arenaceous and the genus should be placed in the Verneuilinidae as a derivative from *Verneuilina,* the position indicated for it by Schubert. *Chrysalidina* is to be distinguished from *Verneuilina* by the numerous rounded perforations of the apertural wall instead of the narrow single aperture of

[1] Received March 1, 1929.

[2] Neues Jahrb. Min. **1907**: 232–260.

[3] Spec. Publ. 1, Cushman Lab. Foram. Research, 1928.

Verneuilina. So far as we now know, it is an end form, as are so many of the genera which have developed sieve-like areas in the apertural face. It is possible that the peculiar form described by Brady as *Bigenerina robusta* has developed from such a triserial ancestry and has assumed a biserial and in some specimens a uniserial development in its later stages, with a sieve-like apertural face. That this form is related to the Palaeozoic *Climacammina* is very improbable.

In his grouping, Schubert derived his genera *Chrysalidinella* and *Chrysalogonium* from *Chrysalidina*. These are calcareous forms and do not belong with the arenaceous *Chrysalidina*, which, as just noted, belongs in the *Verneuilinidae*. The genus *Chrysalidinella* Schubert is monotypic, based on *Chrysalidina dimorpha* H. B. Brady, a species of the tropical seas, at the present time practically limited to the Indo-Pacific but in the Tertiary more widely distributed. This species, the types of which I saw in the Brady collection in London and Cambridge, is calcareous and the early stages are related to *Reussia*, as I have shown. I now have abundant material from the Indo-Pacific showing both the microspheric and megalospheric forms. *Chrysalidinella* is triserial like *Reussia* in its early stages, but becomes uniserial later and has the terminal face with numerous perforations. It is known from the Miocene to the Recent, whereas *Reussia* is known from the Cretaceous and is still living in tropical regions. *Reussia* developed from *Bulimina*, but is distinguished from typical forms of that genus by its triangular shape. The bulimine aperture is, however, still retained.

From what we know of the development of the Foraminifera, a form should occur in which the triserial condition is maintained, but the terminal face should show a sieve-like aperture. Such forms are now found to be abundant in the Indo-Pacific and two new species are figured here from off Fiji. These may be referred to the genus *Trimosina* Cushman, the genoholotype of which is the form figured by Millett as *Mimosina spinulosa* Millett, var. This specimen and others I was enabled to study in the Heron-Allen and Earland collection in the British Museum. In his genus *Mimosina*, Millett included several forms which need much more study. The typical *Mimosina* based on *M. hystrix* Millett I studied in London. The adult is biserial while the young stages, difficult to make out, seem in the microspheric form to be planispiral. Whether this genus is related to *Hantkenina*, as I have placed it, or is a biserial form related to *Trimosina* and *Reussia*, can only be determined by a study of much more material

than is now available. In *Trimosina perforata*, n. sp., figured here, there is a long slit-like aperture with the apertural face having a series of pores. This is different specifically from *Trimosina milletti* Cushman in which the perforate plate is not well developed. That the two are closely related however cannot be doubted when both are studied. Another species from off Fiji, figured here, is more primitive and shows the development from *Reussia* in even more marked fashion. These species of *Trimosina* fill in very well the stages from *Reussia* to *Chrysalidinella*.

The genus *Chrysalogonium* Schubert was based on *Nodosaria polystoma* Schwager, from the Pliocene of Kar Nicobar. It is nodosarian in form but the terminal face has a sieve-plate instead of the typical radiate aperture. This has been the only species known, but in the last year I have had material which can be referred to this genus from as far back as the Upper Cretaceous as well as from other ages, and it can be definitely stated that the genus does not belong, as indicated by Schubert, in the line with *Chrysalidinella* nor in this family. That genus will be discussed in another paper.

The relationships of these various genera therefore are as follows—*Chrysalidina* d'Orbigny is arenaceous and belongs in the Verneuilinidae derived directly from *Verneuilina*. *Chrysalogonium* Schubert is not derived, as Schubert indicated, from *Chrysalidinella*. *Reussia* is derived directly from *Bulimina*, and in turn gave rise to the triserial *Trimosina* Cushman with a sieve-plate and to the uniserial *Chrysalidinella* Schubert.

A description of two new species follows.

Trimosina perforata Cushman, n. sp.

Fig. 1 *a*, *b*

Test small, generally triangular in both side and end views, angles acute; chambers triserial throughout, rapidly increasing in size as added, the angles of the chambers usually protruding and early chambers sometimes twisted; sutures distinct, not depressed, slightly limbate; wall calcareous, finely perforate with coarser perforations along the borders near the sutures connecting with the interior by definite tubules, generally smooth, thin and nearly transparent; apertural face convex, with numerous ridges and irregular projections, aperture consisting of a long narrow opening connecting with the basal margin by a narrow slit at a sharp angle to the axis of the main opening, bordered by a distinct thickened lip, the apertural face with numerous irregularly rounded openings.

Length, 0.50 mm.; breadth, 0.35 mm.

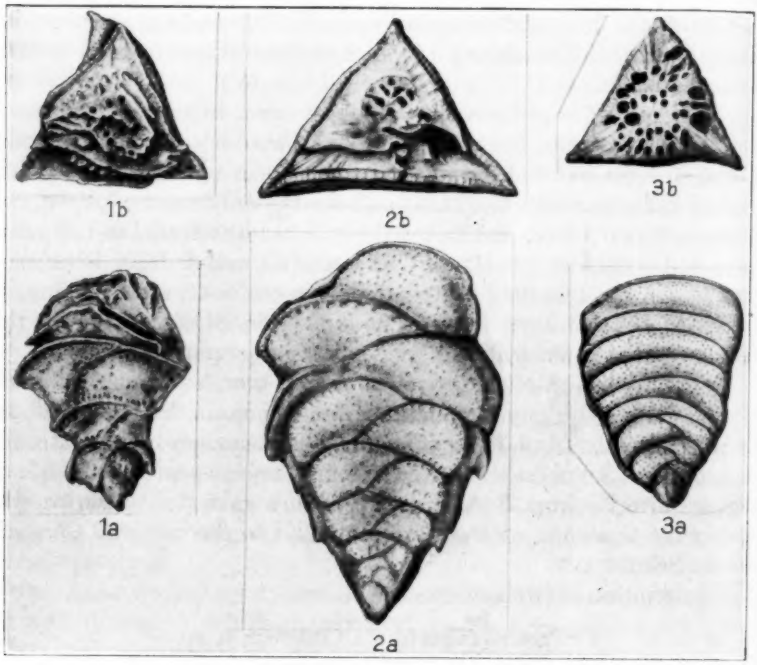
Holotype (Cushman Coll. No. 10363) from 40–50 fathoms off Fiji.

This species may be distinguished from the following by its very angular, coarser chambers, and the greater size of the sieve-plates.

Trimosina simplex Cushman, n. sp.

Fig. 2 *a*, *b*

Test of medium size, triangular in both side and end views, angles acute; chambers triserial throughout, uniformly increasing in size as added, angles of the chambers slightly spinose, the outer angle thickened, almost carinate; sutures distinct, not depressed, very slightly limbate, rather evenly curved;



Figs. 1 *a*, *b*.—*Trimosina perforata* Cushman, n. sp., *a*, front view; *b*, end view.
Figs. 2 *a*, *b*.—*Trimosina simplex* Cushman, n. sp., *a*, front view; *b*, end view.
Figs. 3 *a*, *b*.—*Chrysalidinella dimorpha* (H. B. Brady), *a*, front view; *b*, end view.
All figures × 75

wall calcareous, coarsely perforate, especially along the borders, smooth, fairly thick but translucent; apertural face slightly convex, fairly smooth, the aperture elongate without a lip, and with a few supplementary openings in the center of the terminal face.

Length, up to 1 mm.; breadth, 0.50 mm.

Holotype (Cushman Coll. No. 10365) from 40–50 fathoms off Fiji.

This species is a more primitive one than the preceding, and connects the other with *Reussia*.

In this same material from off Fiji at 40 to 50 fathoms, *Chrysalidinella dimorpha* (H. B. Brady) also occurs in the rather peculiar form shown here (Fig. 3 *a*, *b*). The sides are entire, the later chambers uniserial, and the terminal face with the apertures peculiarly arranged. There are probably several species of this genus which may be possible of separation.

Although all three of the species figured here occur together, they are distinguishable at a glance. The specimens of *Chrysalidinella* may be at once identified by the entire outline even before the uniserial chambers are noted. The two species of *Trimosina* are also strikingly different in general appearance. *T. simplex* has evenly placed and arranged chambers with small spinose projections extending backward at a decided angle, whereas *T. perforata* is a smaller but coarser form, the chambers relatively larger, the projections large and the whole test often twisted.

ZOOLOGY.—*The chromatropism of* Mermis subnigrescens, *a nemic parasite of grasshoppers.*[1] N. A. COBB, U. S. Department of Agriculture.

The adult female *Mermis subnigrescens*, when ripe for ovijection, has a way of moving her head in more or less horizontal curves;—her head, directed skyward, is waved in "circles," now clockwise, now the reverse. This seemingly purposeful behavior occurs when she emerges from the soil and while she is ascending the herbage to deposit her eggs. Inasmuch as the head of the egg-laying female,—unlike that of the *young* female as well as that of the male (neither of which ever quits the subterranean darkness),—contains *reddish transparent pigment* rather definitely distributed with reference to certain cephalic nerves, the question arose whether we do not have here a phototrope[2] and an

[1] Received March 12, 1929.

[2] It is suggested that the mechanisms through whose activation the responses of organisms termed *tropisms* find expression be called "tropes;"—"tropism" to be taken in almost any of its more or less well accepted meanings.

These meanings (interpretations of various investigators,—see Mast, 1915) vary all the way from (1) *"an inherent tendency to respond"* (Standard Dictionary), to (2) an *"irresistible" or "predictable" orientation as definite and mechanical as that of a magnetic needle;* but *whatever* the accepted interpretation, the *reaction-mechanism must always be present, and be a system* of intimately connected elements or organs, as is the digestive system, for instance, or the excretory system. Since we have for this system of intimately connected elements no inclusive single descriptive term, and since it is found highly convenient, or even necessary, for purposes of thought and discussion mentally to "isolate," and separately to denominate, the digestive system or enteron, and other systems, it is suggested that in behavior studies a like situation be met by a similar,

affirmative answer was forecast, for the obvious reason, among others, that, as the pigment must absorb certain light frequencies and transmit others, the absorption might well result in some such changes of energy as characterize vision. Very suggestive also is the fact that the transparent, colorless parts of the head immediately in front of, and alongside, the suspected phototrope condense light rays upon it. (See Fig. 1.)

Previous experiment showed the spectrum frequencies concerned in bringing about ovijection in this nema probably to be some of those in the light-blue and low violet region of the spectrum, together with red (also infra-?).[3] It would therefore be natural to suspect, under all the circumstances, that the cephalic pigment characteristic of the adult female absorbs, and "makes use of," the frequencies *present* just previous to and during ovijection. Hence a wish, (1), to determine what frequencies are present during and just previous to natural ovijection; and, (2) to determine what frequencies are absorbed by the cephalic pigment.

In this field comparatively little seems to have been published, though somewhat pertinent papers by Crozier, Mast, and others exist. Investigators have been mainly occupied with the optics of the various colorless, transparent, organic elements; the relative location and probable function of certain pigments, usually dark or black (opaque); and the "migration" and other changes of pigment, such as visual purple, due to the action of light; and, of course, with the associated nervous and contractile elements. Little has been published with regard to tropism definitely due to the absorption of rays of a *particular* frequency solely by transparent, colored pigment (other than visual

but if possible better (to wit monosyllabic), terminology. The advantages of a monosyllable from which short, convenient adjectives, verbs, adverbs and other nouns can readily be derived, are almost too obvious to need mention,—tropic, tropically, to trope, troping, etc., etc. Most helpful, perhaps, will be its use as a component, e. g., in "chromatrope."

Primarily "trope" denotes action,—action that is in progress rather than completed. By metonymy the word denoting an action (here, what is called a reaction) may be applied to the (re)action-mechanism, i.e., in the present case, to the responding system of intimately connected organs.

Following this suggestion, we may speak of a reaction mechanism that aids or causes an organism to face toward or away from light, as a *phototrope;* a reaction mechanism used in orientation with reference to gravity, a geotrope, etc., etc., etc., etc.; thus the statocystic mechanism of crustaceans is a species of geotrope.

Accordingly, certain cephalic apparatus of *Mermis subnigrescens* is here spoken of as a phototrope; or, better, because more specific, as a *chromatrope,*—inasmuch as its reactions apparently are to definite frequencies (colors) of the solar spectrum. *Glaucotrope* γλαυκος = blue) may prove to be even more precise.

[3] *Species of Mermis.* Journ. Parasitology, **8**: 66. 1926.

purple) located definitely with reference to nerves, these nerves themselves so located as possibly to be sensory.

SPECTROSCOPIC TEST OF THE PRESUMPTIVE CEPHALIC CHROMATROPE OF *Mermis subnigrescens*

One-third of a millimeter of the front end of an adult female *Mermis subnigrescens*, including the head, was ligated and cut off, and then mounted on a microscope slide in water. The head was examined under a 1.5 mm. apochromatic microscope objective, having a similar objective as a condenser, in such a way that the image would fill as much as possible of the microscope field with the color of the pigment. (See Fig. 1.) The microscope was fitted with a spectroscopic eyepiece.

Sunlight was taken from a planished aluminum reflector placed so that a maximum of sunlight was reflected through both instruments,—*i.e.*, the above apochromatic-micro-spectroscope and a comparison spectroscope. The pigmented tissue was brought into focus, and then the iris diaphragm of the microscope thrown open, so as to admit a "flood" of light. This produced a spectrum fairly readily seen in a darkened room, notwithstanding the very high magnification.

Much of the violet end of the spectrum (well into

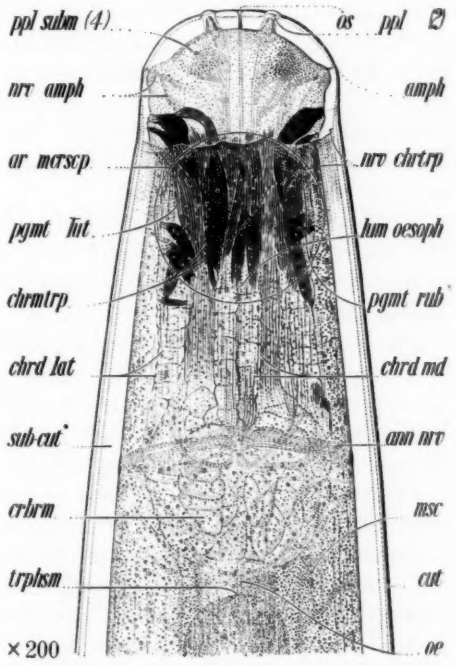


Figure 1. Head end of *Mermis subnigrescens*, showing the chromatrope. *os*, mouth; *ppl* (2), the two lateral so-called "papillae;" *amph*, amphid; *nrv chrtrp*, nerves of the chromatrope; *lum oesoph*, lumen of the oesophagus; *pgmt rub*, reddish pigment of the chromatrope; *chrd md*, median chord; *ann nrv*, nerve-ring; *msc*, body-wall muscles; *cut*, cuticle; *oe*, oesophagus; *ppl subm* (4), the four submedian papillae; *nrv amph*, nerve of the amphid; *ar mcrscp*, shows the circular area of the microscopic field that was tested spectroscopically; *pgmt lut*, orange-colored pigment of the chromatrope; *chrmtrp*, chromatrope; *chrd lat*, lateral chord; *sub cut*, the thick subcuticle; *crbrm*, the cerebrum; *trphsm*, anterior end of the trophosome.

the blue) was absorbed to a very considerable degree by the living cephalic pigment of the *Mermis subnigrescens*. The microscope field was never completely and uniformly filled with the color of the pigment. There were streaks at each margin of the field, and another through the middle, that showed little color (see Fig. 1), so that doubtless the absorption was not so pronounced as would be obtained by dissolved pigment of equal density filling the entire field of the microscope.

A satisfactory demonstration was made by placing the object under the microscope so as to produce absorption, and after the spectra had been arranged for comparison, suddenly removing the pigmented tissue. *The effect produced by this instantaneous change was very pronounced.* The blue and violet region of the spectrum, hitherto obscured by absorption, of course instantly assumed the same colors as in the comparison spectrum.

There seemed also to be some absorption in the outermost part of the red of the visible spectrum, but, if so, it was very slight. No absorption was noticed in the orange, yellow and green, and little if any in the bluish green.

The experiment was particularly satisfactory in that the pigment was *in a living condition*. True, the head had been ligated and cut off immediately before the spectroscopic examination, but from much experience it is known that such a head continues to live and move anywhere from a few hours to a day, or even more.

Phototropes of somewhat the character here described probably occur in the cervical region of many other nemas, particularly free-living ones,—the outer tissues of the neck serving as a cylindrical lens for condensing light upon the pigmented tissues. Aquatic nemas so situated as to utilize light rays penetrating water, not infrequently present structures that may be suspected to be phototropes,—now that we have a clue to the nature of such structures in this phylum. These primitive phototropes may well have been the forerunners of the more highly developed phototropes, ocellate systems, of certain nemas (e.g. *Enchelidium*).

A general review of the nature and relationships of localized transparent pigments in organisms in the light of the foregoing experiment, may, perhaps, suggest new ideas and experiments with regard to their functions both in animals and plants.

NATURAL CONDITIONS UNDER WHICH *Mermis subnigrescens* DEPOSITS ITS EGGS.

At Woods Hole, Mass., U. S. A., on July 28, 1928, from long before daylight up to 10 o'clock A.M. the weather was warm and showery. The showers were gentle but subcontinuous, with light-intervals between; *i.e.*, during two or three brief intervals the sunlight actually came through the fog and clouds rather clearly.

Two full-grown female specimens of *M. subnigrescens*, very much alike, were found depositing eggs naturally on grass etc. in an experiment field. As each nema still contained a good many eggs, both were taken to the laboratory in cold tap-water, and both subjected to radiant heat of low frequency, emanating from hot steel. The results of three trials on one of the nemas and four on the other were quite consistent.

An ordinary steel file about nine inches long and three-fourths of an inch wide was heated until hot, though not red. As near as could be judged the temperature of the file during the trials was from 400°–500° C. The hot steel was held within an inch and a half to two inches of the nemas. Held at this distance from one's cheek, it caused an agreeable warm sensation;—no disagreeable sensation of heat, however,—no suggestion of scorching.

When the nemas were brought into the laboratory, both were still slowly depositing eggs; one, however, very slowly,—putting out only one or two eggs semi-occasionally. When one of these ten-centimeter nemas in this laboring condition was removed from water and stretched out on a broad-leaf plantain, *Plantago major*, and the hot file brought near, she immediately responded by increased rapidity of movement, and in from ten to twenty seconds became coiled, sometimes rather closely, so that the entire space occupied by her would not be over fifteen to twenty millimeters across. Barely enough water was used on the plantain leaf so that only at her points of contact with the leaf was she in contact also with water. Doubtless the warmth may have caused the water to evaporate a trifle more rapidly, notwithstanding the saturated condition of the atmosphere, and one cannot say that this change in rate of evaporation may not have had some effect on the behavior, but the inevitable inference is that the "radiant heat" caused the change in behavior, corroborating, in a reverse way, experiments of previous years with direct sunlight and sunlight passed through heat-diminishing screens (both green glass and living foliage).

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After the nemas had been rayed and returned to water in a watch-glass, and after they had resumed their former less active somewhat outstretched state, they were tested again and again with the infra-red rays. Two observers, noting the nemas before they were removed from the watchglass of water and after they had been rayed, declared the ovijection to be stimulated, and in one case the stimulation to be very marked indeed. In this case, at the time when the nema was removed from the glass, oviposition was diminishing to almost nil, only now and then an egg being deposited,—at intervals of half a minute or thereabouts; however, after she had been rayed and returned to the water where her behavior could be observed more accurately, deposition was going on vigorously,—batches of something like twenty eggs were being ejected at intervals of five to ten seconds. It should be remembered that these two females *already had their egg-laying capacity partially exhausted* and were therefore probably less favorable specimens for experiment than if they had just issued from the ground.

The conclusions drawn from the experiments were that, without doubt, *the radiant heat from the hot steel met with instant response by the nema and that the response was very definite and that the egg deposition was very markedly stimulated by the rays.*[4]

Apart from ultra-violet, apparently very little is known about the relative *amounts* of various light frequencies that are passed through different quantities of fog and watery vapor in the atmosphere. It is known that fog and vapor are more or less impervious to ultra-violet, but pervious to many other frequencies, among them blue and a certain amount of red and infra-red. However, nobody appears to have devised a method or instrument by which the amount of any particular one of these various other frequencies penetrating *under various atmospheric conditions* can be satisfactorily measured, although there is reason to hope that such data can be established.

It is very evident, however, that during the morning under consideration, which was showery with light rain much of the time, the weather varying all the way from thick fog to almost sunny,—fog so thick that the fog-horns were blowing, and yet at times the sky toward the east such that the sunlight came through rather clearly,—it is very evident that the amount of any given spectrum frequency reaching the experiment field probably would vary during the morning nearly through the entire daylight scale, or at least much of it.

[4] But whatever stimulus, if any, the nema received from the sky was not sufficient by itself to cause any marked oviposition.

APPLICATION TO THE OVIJECTION OF *Mermis subnigrescens*.

The observations to date seem to shut out the possibility that ultra-violet has much of anything to do with ovijection taking place naturally in the open. The present observations seem *again* to make it exceedingly probable that radiant heat must have much to do with it. Recalling that the early morning light is relatively rich in red and infra-red, and that as moisture (dew, rain) is essential, or at any rate highly favorable, to the oviposition of *M. subnigrescens*, then obviously early morning and forenoon would be a favorable time of day for the oviposition. It is certain, from spectroscopic tests made during the morning in question, that *all* the time after sunrise a good deal of blue light was being passed through the atmosphere; and it therefore might have been a behavior stimulus, and no doubt was so.

All this harmonizes with previous experiments on the ovijection of this species,—an account of which is already published,— and explains the motive for the tests described above.

Thus we have a fairly complete theory of the above-ground egg-laying activities of *Mermis subnigrescens*. When the nema is ripe for labor, she moves from her pitch dark, subterranean "domicile" to the surface of the ground. Her movements during this trip no doubt exemplify apogeo-, hydro-, thermo-, rheo-, thigmo-, and finally, just before she reaches the surface, photo-tropism.

Once her head is free of the surface of the ground, her chromatrope comes into full play, "detecting" the direction and amount of light from the sky, particularly, perhaps only, blue light. The structure of the chromatrope is particularly adapted to the reception of light *from above* or *from any side*, for the light will be concentrated in the chromatrope by the transparent front tissues of the head acting as a hemispherical lens, and the side tissues acting as a cylindrical lens.

As she clambers higher and higher on the herbage, she responds to such blue sky light as is not intercepted by the green blades of grass and other foliage above and around her. Led by the blue light and the urge to deposit, she will at last reach an elevation on the herbage subject to a more direct action of the sun's rays, when the ovijector and uterine muscles will be affected by red rays and ovijection will begin; and this place in many instances would be *at the altitude of grazing grasshoppers*, the definitive hosts.

This would be a new and special parallel to the ordinary sequence of events in ovijection and parturition. In other words the "voluntary" nervous system comes first into play, bringing the organism into con-

ditions favorable to the events about to follow. Thereafter the behavior is more or less "involuntary," as has been shown in the present instance by the fact that ovijection continues under the stimulus of sunlight, even if the head, including the chromatrope and central nervous system, be removed,—seared off.

CIRCUMSTANTIAL EVIDENCE FOR THE CHROMATROPISM OF *Mermis subnigrescens*

1. The commonly infested grasshoppers graze mostly within certain limits above the ground; harmoniously, the eggs of the mermithid parasite are found to occur preponderantly within these limits, suggesting highly developed egg-laying instincts on the part of the nema that might well presuppose tropism.

2. A definite mechanism, believably a phototrope [includes chromatrope, (includes glaucotrope)] embodying what are believably receptors, transmitters, and effectors, is present;—a mechanism not otherwise readily explicable. The only mermithid individuals known to possess such a mechanism fully developed are those whose *blackish eggs are deposited in the way* characteristic of *Mermis subnigrescens.*

3. The putatively-chromatropic pigment absorbs,—i.e., can be sensitive to,—blue rays.

4. Only adult, chromatroped, egg-laying females clamber as described. Males and young females having no power, or occasion, to deposit eggs are not chromatroped.

5. The clambering of the nemas ripe for oviposition is skyward;—*i.e., toward blue sky, rather than vertical* (distinction from negative geotropism). Beams of blue light *from the sky*, often oblique, and coming from many widely different directions, are those most certain promiscuously to penetrate the depths of the herbage, and thus reach to near the ground. The nema's lens-like tissues concentrating light upon the chromatrope, accept it from above and from all sides; this harmonizes with the distribution of blue sky light.

6. Oviposition is stopped, or very much slowed, by green screens (including living foliage) that absorb red and infra-red; indicating a necessity for the nema to escape from exclusively green light before oviposition can take place. In the grasshopper habitats, blue light (sky-light) is the most diffused and most likely to be useful in leading to the known consummation, should chromatropism come into play at all. In nature, clambering skyward ("blue-ward") from out the green, brings the nema soonest under the incidence of the longer wave lengths so stimulative to the ovijectors.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

THE ACADEMY

222D MEETING

The 222d meeting was held in the Assembly Hall of the Cosmos Club on the evening of Thursday, October 18, 1928.

Program. Prof. WALDEMAR G. BOGORAS-TAN delivered an illustrated address on *Cultural and Scientific Work among the Primitive Tribes of Siberia.*

The so-called "lesser nationalities of the North" represent small groups of people more or less primitive, each group with a membership scarcely more than a couple of thousand or so, scattered over an immense area of tundra and forest. The whole population of these twenty-odd tribes is between one hundred and fifty and two hundred thousand. Among them are: the Chuckchee, the Koryak, the Kamchadal, the Asiatic Eskimo, the Aleut, the Yukaghir, the Chuvanzi, the Ghiliak, the Yenisseian, the Dolgan, the various branches of the Tungus and the Lamut, the Gold and the Olcha, the Orocha, the Ude of the Amur country, the Orok of the Saghalien, the Karagas and the Soyot of the Sayan Mountains. These last are the most primitive tribes among the Siberian Turki people. Here belong also the Sayomed, the Ostyak, the Vogul, and the Lapp.

Our scientific work among these tribes represented the development of the studies undertaken by the Jesup North Pacific Expedition among the Asiatic part of Circumberingian people. Thirty years ago we called these tribes "Americanoid tribes of Northeastern Siberia," but in latter years the circle of this research widened and several other groups appeared as very similar to the Northeastern Americanoids in most of the conditions of their life and culture. We call these tribes at present Proto-Asiatic, which from the point of view of an Americanist means to imply that at some stage of their early history they presented a close resemblance to the Proto-American, who, much later on, were connected with Asia in various branches of their life and culture.

When, after the War and the Revolution, we resumed our scientific work among these tribes of northern and northeastern Siberia, we had first of all to solve some very important practical problems referring to the well-being and to the very life of these tribes which until then were only an object of our scientific research. For several centuries before the War these tribes were oppressed and threatened with extermination. The Revolution and the civil disturbances brought them to utter destitution and even carried them to the brink of starvation. In order to improve this nearly castastrophic condition of things there was organized in 1924, partly on the suggestion of Waldemar Bogoras, a special "Committee for Assisting the Lesser Nationalities of the North," in abbreviation, the Northern Committee.

Among the measures introduced and carried through by the Committee may be mentioned:

1. The remission of all taxes and direct payments in the Polar districts.
2. The complete abrogation of all military service by the natives.
3. An increase of the necessary supplies and provisions imported into the northern countries and an improvement of their quality.
4. The organization of self-government and of native jurisdiction; this has led to increased self-confidence among the tribes.
5. Credits have been given to the reindeer breeders and insurance of the herds is being introduced.

6. Measures for the protection of fur-bearing animals have been introduced and are being carried through.
7. Land surveys are being undertaken to protect the territories of the natives against colonists.

A peculiar type of the so-called "cultural bases" was introduced. These bases represent special settlements arranged in the very middle of native territory at a distance from Russian settlements and villages. Three of such bases are already started. Each of them includes a hospital, a veterinary institution, a school of higher type, a coöperative store, a standard reindeer herd, and some model workshops for operating with local material. A local official center is also established there. "For the native and through the native" is the motto of the whole cultural work of the Northern Committee.

Since the northern natives bring to the State a good half of the most valuable peltries, such as sable, ermine, white and red fox, gray squirrel, etc., and since reindeer breeding, which is most important in the community life of northern Eurasia, was created and is carried on solely by northern natives, it was but fair for the Russian State in its period of new organization to spend some part of its income on improving the miserable conditions of those hard-driven stepsons of civilization.

In the matter of education, fifty schools, with free board, were arranged, having 800 pupils. (In 1926–27 there were only twenty-five schools.) A special college of higher type was established in Leningrad with 300 students, and smaller colleges in Khabarovsk, Amur country, and Irkutsk, Siberia. The Northern College of Leningrad is of special interest. It was started in 1924, with sixty students. In 1927, it had 192 students, among whom were twenty girls. The yearly expenses were $150,000. This year the number of students will be 300. The college forms at present an important section of the great Leningrad Eastern Institute. The students represent twenty-four tribes of those mentioned above. The Leningrad Eastern Institute is now embodied in the Geographical Department of the University of Leningrad, which has an ethnographical section of eight branches. About twenty-five of the young scientists in the Department pursue cultural and scientific work among the tribes of the north. Their work includes teaching and field activities among the natives. In the scientific investigations the Museum of Anthropology and Ethnography of the Academy of Sciences coöperates with the Ethnographic Section of the University. Several expeditions are organized every year for field work in Northern Siberia. The studies include problems of material and social culture, of religion, folklore and linguistics. Effective work is being done to raise the cultural level and the standards of living of the tribes. (*Author's abstract.*)

223D MEETING

The 223d meeting was under the joint auspices of the U. S. Navy Department and the Carnegie Institution of Washington, and was held in the Auditorium of the Interior Department Building on the evening of Tuesday, Dec. 4, 1928. After calling the meeting to order, Vice-President HEYL turned the chair over to the Secretary of the Navy, Hon. CURTIS D. WILBUR, who presided during the rest of the evening.

Program. Dr. F. A. VENING MEINESZ, member of the Netherlands Geodetic Commission, Professor of Geodesy at the University of Utrecht, and honorary member of the Academy, delivered an illustrated address on *Gravity Measurements at Sea and their Significance.*

Gravity at sea may be found with the necessary accuracy of 1 part in 250,000. The same pendulum method is used as has already been used satisfactorily on land; it is well known that the period of a pendulum is dependent on the value of gravity, and therefore by determining this period gravity may be deduced. Of course this method has to be adapted to meet the difficulties due to disturbance by the motion of the ship. This may be done by swinging two pendulums together in the same plane of oscillation. The horizontal movements, which cause the greatest disturbance in the pendulum motion, are thus the same for both pendulums and consequently their effect may be eliminated. By combining the movements of the two pendulums in the right way we can find a result that is free from the disturbance. The apparatus makes this combination automatically, so that the photographic records give quite regular curves, although each pendulum by itself is much disturbed. A great many other smaller disturbances have to be taken into account, but these do not present difficulties. The method can, however, only be applied if the ship's movements do not exceed a certain limit, and this makes it necessary to work in a submerged submarine; in this way the ship may descend to a depth where the wave motions are small and a sufficiently steady platform is obtained.

The purpose of gravity measurements is twofold. The first is the determination of the figure of the earth. The theory of the gravitational potential shows that this figure may be computed if gravity be known over the entire surface of the earth. It is clear that this implies the making of gravity measurements at sea, but this is the only way to determine the complete figure of the earth: the other geodetic method, that of arc measurements, can be applied only on the continents. This point is of especial importance because the results of the recent investigations tend to show that the figure of the earth is slightly irregular, deviating over extensive areas perhaps as much as 500 feet from an ellipsoid of rotation. The continental measurements alone are therefore insufficient to give the complete figure of the earth. A few cruises over the oceans would contribute an important part of what is needed. In this way gravity work at sea is of basic importance for geodetic and hydrographic work and for all map and chart making.

The second purpose of gravity investigations is to obtain data for the study of the earth's crust. From these measurements we get indications regarding the distribution of abnormal masses in the crust. These may be used for geological studies and for a study of the physical behavior of the crust. In this way the values on the continents have led to the discovery of isostasy, that is, the fact that the earth's crust is in floating equilibrium on the subcrustal layers, which though viscous have, nevertheless, enough fluid properties to allow the crust to sink into them till equilibrium is reached.

The first problem of gravity observations at sea is to learn whether this equilibrium is also present at sea. If a deviation is found, there are three possibilities. First, the gravity anomaly may be caused merely by a wrong assumption about the way in which the masses in the crust are distributed, so that the departure from equilibrium may be only apparent and not real. This can, however, never cause other than local anomalies. Secondly, it may be that the cause that has brought about the deviation from equilibrium is no longer active, and that the deviation is caused by the lag in the restoration of equilibrium due to the viscosity of the subcrustal layers. Thirdly, and most important, the departure of equilibrium may be caused by stresses working in the crust or in the subcrustal layers. These data would in this way give us a means of stating these stresses and of computing their intensity,

and thus of finding the causes of the deformations in the earth's crust. The following problems in connection with gravity work at sea may be indicated; the list however is not meant to be exhaustive.

Gravity over the open oceans. The few observations now available seem to show that, although roughly speaking isostasy is present, there are extensive though not very considerable excesses of gravity in the Atlantic and the Pacific Ocean. It would be important to investigate this further in order to see whether these results are confirmed elsewhere and whether their distribution shows a general relation to the distribution of sea and land on the earth's surface, as now appears to be the case.

Gravity along the continental shelf. On this question the voyage of the U. S. S. S-21 has given valuable data. The results obtained along the shelf between the West Indies and Cape Hatteras show, as far as can be seen from the provisional results, the same curious anomaly that has been found also on the Pacific Coast of Central and North America: an excess along the foot of the slope. An interpretation of this result must wait till the figures are accurately known and can be studied.

The investigation of inland seas. Here also the expedition brings back an increase of knowledge: a series of observations have been made over the Mexican Gulf, which show a remarkable excess of gravity. The Mississippi delta had been investigated by means of two profiles of stations running up to the coast, but apparently there is no evidence that this delta is playing any rôle in this departure from equilibrium.

The investigation of ocean deeps. These deeps are suspected to be recent deformations of the earth's crust where stresses are probably still present: the earthquakes in these regions confirm this supposition. A great many detailed data were gathered during the expedition regarding two of these deeps: the Bartlett deep south of East Cuba and the Nares deep north of Porto Rico. The results fully agree with the expectations. The latter deep especially shows big departures from equilibrium, and a detailed study of the final results will help to understand the deforming stresses which are acting there. It may be added that gravity observations north of Haiti and north of East Cuba show that these stresses continue much further westward than the deep itself would indicate.

Much credit is due the authorities of the U. S. Navy and the Carnegie Institution of Washington for undertaking this scientific investigation and organizing this expedition, and to the commander of the U. S. S. S-21, Lieut. J. L. Fisher, who by ordering all the submergences necessary for the measurements made it possible to get the numerous results which were brought back, and to the helpful assistance given during the whole voyage by the officers, Lts. Hall, Hamblin and Sodergren, and by the crew. The great number of submergences, 49 in all, of which there were often several in one day, were an additional strain on everybody. (*Author's abstract.*)

Dr. F. E. WRIGHT of the Geophysical Laboratory of the Carnegie Institution delivered an illustrated address on *The Trip of the U. S. S. S-21.*

The recent 7000-mile cruise of the U. S. S. S-21, Lt. J. L. Fisher commanding, over the Gulf of Mexico and the Caribbean Sea for the purpose of measuring gravity at selected points was remarkably successful. At no time during the voyage was there trouble with the operation of the submarine or with the gravity-measuring apparatus. This bespeaks capable officers and an efficient crew to maintain in good working order the mass of complex machinery that is crowded into a submarine. During the cruise 46 gravity stations at sea were occupied. Measurements were made over the Bartlett Deep,

the Nares Deep, the Mississippi delta, the continental shelf and certain extended portions of the Gulf of Mexico, the Caribbean Sea, and the Atlantic Ocean. The isostatic gravity anomalies deduced from these measurements through the active coöperation of the U. S. Coast and Geodetic Survey indicate that the Nares Deep is an uncompensated geologic feature in which shearing stresses of large magnitude are present in the earth's crust; likewise the eastern part of the Bartlett Deep and Virgin Island Deep. The Mississippi delta is practically compensated in spite of the fact that each year a load exceeding one twentieth of a cubic mile of sediment or nearly 12 billion tons is being laid down. On the other hand large positive anomalies over the deeper portions of the Gulf of Mexico, the Caribbean Sea, and the Atlantic Ocean indicate a condition for which a satisfactory explanation has not yet been found. The same condition obtains over the Pacific Ocean in so far as measurements have there been made.

Life aboard a submarine was described briefly; incidents of the voyage were illustrated by lantern slides. Notwithstanding the discomforts that necessarily exist in a submarine because of limited quarters the crew and officers of the submarine at no time complained, but were always ready and eager to aid the scientific work whenever possible and to dive at any time of day or night. The efficiency of the Navy in undertaking a project of this nature and carrying it through without a hitch formed a most impressive exhibit of preparedness for any emergency. (*Author's abstract.*)

After their addresses the speakers answered various questions by the presiding officer and members of the audience.

WALTER D. LAMBERT, *Recording Secretary.*

SCIENTIFIC NOTES AND NEWS

A comparison of the electrical conductivity of copper and aluminum is of special interest at the present time when they happen to be selling at the same price, 24 cents a pound. The same weight of aluminum, in this case the same money's worth, will offer twice the electrical conductivity for the same length, or for wire of the same diameter the aluminum wire will be 3.3 times as long as the copper wire, although in this case its conductivity per unit of length will be only 61 per cent of that of copper.

VICTOR C. HEIKES, long engaged in work on mineral resources in Salt Lake City, has been placed in charge of the Mineral Statistics Division of the San Francisco office of the Bureau of Mines, formerly under the direction of JAMES M. HILL, now resigned.

E. P. KILLIP, Associate Curator, United States National Herbarium, A. O. SMITH, and W. J. DENNIS left Washington March 25th for botanical exploration of northern Peru and the upper Amazon. They expect to be gone about 7 months.

The United States Geological Survey celebrated its 50th anniversary on March 21, just half a century after the appointment of its first Director, CLARENCE KING. The President of the United States, who began his geologic career thirty-five years ago as a field assistant on the Survey, received the members of its staff at the White House, and then joined them for a group picture on the lawn. Later Mrs. HOOVER received the group in the East

Room, and welcomed them as fellow geologists because of her own training in that subject. In the afternoon addresses celebrating the occasion were given at the National Museum auditorium by the Secretary of the Interior, RAY LYMAN WILBUR, H. FOSTER BAIN, formerly Director of the Bureau of Mines and now Secretary of the American Institute of Mining and Metallurgical Engineers, ARTHUR E. MORGAN, President of Antioch College, HENRY FAIRFIELD OSBORN, President of the American Museum of Natural History, ARTHUR L. DAY, Director of the Geophysical Laboratory, and JOHN C. MERRIAM, President, Carnegie Institute of Washington. In the evening nearly 600 members and friends of the Survey gathered at a banquet in the Hotel Washington; the program included several brief speeches and playlets and ended with a dance. Many of the former geologists and other scientific men of the Survey were present, including H. F. BAIN, MYRON L. FULLER, E. W. PARKER, WALLACE W. ATWOOD, GEORGE H. ASHLEY, K. C. HEALD, and M. O. LEIGHTON.

E. F. BURCHARD, Geologist, will be on leave from the Geological Survey for two months to engage in commercial work in South America.

FRANK REEVES and C. P. ROSS, of the U. S. Geological Survey, have returned from two months work on the Panama Canal Zone, where they examined the proposed Alhajuela dam and reservoir sites for the Panama Canal.

ROBERT RIDGWAY, curator of the division of birds in the U. S. National Museum since 1876, died on March 25, in his seventy-ninth year.

The Emeritus Professors of the George Washington University were entertained at a luncheon in their honor by the President of the University, Dr. CLOYD HECK MARVIN, on March 26, at the Cosmos Club. Included in the company were the following distinguished men of science: JAMES HOWARD GORE, mathematician and astronomer, who has represented the United States at numerous scientific congresses abroad and who has been decorated by eight foreign countries; HARRY CRECY YARROW, formerly curator of the Division of Reptiles of the United States National Museum, for thirty years Acting Assistant Surgeon of the United States Army; DANIEL KERFOOT SHUTE, ex-president of the Medical Society of the District and of the Society of Opthalmologists and Otologists of Washington; WILLIAM KENNEDY BUTLER, physician; CHARLES EDWARD MUNROE, inventor of smokeless powder, Chief Explosives Chemist of the United States Bureau of Mines; CHARLES WILLIAMSON RICHARDSON, ex-president of the Medical Society of the District; GEORGE PERKINS MERRILL, Curator of the Department of Geology of the United States National Museum; STIRLING RUFFIN, physician.

The tenth annual meetings of the AMERICAN GEOPHYSICAL UNION and of its sections will be held in the National Academy and Research Council Building, Washington, D. C., April 25 and 26, 1929. Following the business meeting of the General Assembly of the Union on the afternoon of April 26, the Union will hear the five following general-interest papers presented by the Section of Oceanography; these all concern work in progress or recently completed: *The expedition of the submarine S-21 to the Caribbean Sea and*

Gulf of Mexico, by C. S. FREEMAN; *Oceanography and the fisheries*, by HENRY B. BIGELOW; *The international ice patrol, with special reference to its economic aspects*, by EDWARD H. SMITH; *The coöperative survey of the Great Lakes*, by CHARLES J. FISH; *The work of the* CARNEGIE *to date*, by W. J. PETERS.

The meetings of the six sections will be held on the mornings of April 25 and 26 and the afternoon of April 25. For each Section short business meetings will be followed immediately by progress-reports and scientific papers. The Section of Geodesy (morning April 25) will be devoted to progress-reports and recent developments in gravity and geodetic work in Mexico, Canada, and the United States as follows: *Gravity-work in Mexico during the past year*, by PEDRO C. SANCHEZ; *Gravity-comparisons in Europe and America*, by A. H. MILLER; *The measurement of gravity at sea*, by F. E. WRIGHT; *Recent developments in time-service methods*, by C. B. WATTS; *Recent developments in geodetic instruments*, by D. L. PARKHURST; *Geodetic work in Canada during the past year*, by NOEL OGILVIE; *Geodetic computations and investigations*, by H. G. AVERS; *Accomplishments in field geodesy during the year April, 1928, to April, 1929*, by WILLIAM BOWIE. The Section of Terrestrial Magnetism and Electricity (morning April 25) will hear a symposium on physical theories of magnetic and electric phenomena including the following papers: *The corpuscular-ray theory of aurora*, by N. H. HECK; *The ultraviolet-light theory of aurora and magnetic storms*, by E. O. HULBURT; *The atmospheric dynamo-theory of variations in earth-currents and terrestrial magnetism—a review*, by O. H. GISH; *A tentative theory of the permanent magnetic field of the sun and earth*, by Ross GUNN; *Echo-sounding of the Kennelly-Heaviside layer*, by M. A. TUVE.

The Section of Oceanography (afternoon April 25) will hear the following communications: *Oceanography and meteorology*, by CHARLES F. BROOKS; *Oceanography and littoral geology*, by DOUGLAS W. JOHNSON; *The significance of plankton-investigations*, by CHARLES J. FISH; *Oceanographic observations in Monterey Bay, California*, by HENRY B. BIGELOW; *Recent work on the dynamic oceanography of the North Atlantic*, by C. O. ISELIN; *Echo-sounding*, by W. E. PARKER. Additional oceanographic papers of general interest in this vast field will be presented as indicated above at the General Assembly on the afternoon of the following day. The Section of Volcanology (afternoon April 25) will hear and discuss the following papers: *Volcanic oceanic islands*, by H. S. WASHINGTON; *Volcanoes of Java and Bali*, by E. G. ZIES; *The volcanic history of the San Juan Mountains, Colorado*, by E. S. LARSEN; *Recent eruptions of Kilauea*, by T. A. JAGGAR.

The Sections of Meteorology and Seismology will hold meetings on the morning of April 26. The first will be devoted to the *Report of the meteorological division of the Committee on the Physics of the Earth*, which will include the following: *Introduction*, by H. H. KIMBALL; *The origin and composition of the atmosphere*, by W. J. HUMPHREYS; *Meteorological data and meteorological changes*, by C. F. MARVIN and A. J. HENRY; *Solar radiation and its rôle*, by H. H. KIMBALL; *Meteorology of the free atmosphere*, by W. R. GREGG; *Dynamic meteorology*, by EDGAR W. WOOLARD and HURD C. WILLETT; *Physical basis of weather forecasting*, by CARL-GUSTAF ROSSBY and RICHARD H. WEIGHTMAN. The scientific program of the Section of Seismology will include: *Surface-waves*, by J. B. MACELWANE; *Forces and movements at the earthquake-origin*, by H. F. REID; *The velocity of surface-waves*, by F. NEUMANN; *The seismicity of the arctic as indicated by instrumental data*, by E. A. HODGSON; *Earth-vibrations from dynamite blasts*, by L. D. LEET.

The scientific sessions are open to persons interested in geophysics, whether members of the Union or not, and all such are cordially invited to attend. These annual meetings are increasingly interesting each year, not only because of the stimulus afforded the study of problems concerned with geophysics but also by reason of the coöperation of the corresponding geophysical organizations of Canada and Mexico which is making for initiation and coordination of geophysical researches depending upon international and national coöperation.

JNO. A. FLEMING, *General Secretary.*

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